Insights on Coal Development from Five Retired Fish and Wildlife Biologists: Submission to the Alberta Coal Policy Committee

Prepared by:

Lorne Fitch, Jeff Kneteman, Richard Quinlan, Kirby Smith, George Sterling

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Executive Summary:

As former Provincial Fish and Wildlife biologists with extensive experience with land use, our observations, monitoring and research provide the following conclusions on coal development in the Eastern Slopes of Alberta's Rockies:

- Despite the scope and scale of coal exploration programs, they are not subject to any appropriate level of impact assessment, or oversight.
- Cumulative effects assessments are not undertaken for coal exploration programs and, when done for coal development, are too narrow in scope to be effective predictors of issues and impacts.
- Coal mining operations in mountain and foothill settings, with steep terrain features are (and will be) subject to repetitive slope, road and settling pond failures, despite the application of engineering solutions. There are a litany of environmental issues and costs as a result.
- There is much reliance on modelling to predict impacts and the outcomes of mitigation strategies. Models commonly best serve to provide a hypothesis to test, but coal interests frequently present models as definitive, particularly with respect to abilities to ameliorate adverse effects. Modelled results are only as good as the data used for input and need to be verified to provide a sense of reality. Case studies (actual monitored results of impact effects and mitigation undertaken) would provide more certainty and aid in decision making.
- Assumptions made by coal mine proponents need to be tested through a synoptic review of other surface coal mines in Alberta and adjacent jurisdictions, but never are.

- There is a tendency for coal mine proponents to avoid answers to some impacts by deferral to some other unstated, subsequent plan, action, monitoring, design or concept. It is virtually impossible then, to realistically determine outcomes and consequences of some mine operations and their cumulative impact on fish and wildlife populations, habitats and on native plant communities.
- Uncertainty is used to conclude that precautionary or remedial actions are not required, rather than incorporating it into operational planning, with appropriate references to causes, interrelationships, consequences and areas where extreme caution is required.
- Adaptive management must include a detailed experimental design (not just monitoring) and clearly articulated options to address the outcome of the experiments. Adaptive management employed by industry is commonly just business as usual with some form of monitoring that is not responsive to immediate problems and has little purposeful capability to address solutions.
- Coal exploration and mining negatively impacts fish and wildlife populations and native plant communities. The risks to biodiversity are consistently underestimated, understated and imperfectly assessed.
- Mitigation/compensation actions proposed and undertaken tend to be untested, unproven, unsuitable, theoretical and overly optimistic.
- In most cases, monitoring proposed and undertaken for both coal exploration and development is not rigorous, robust or sensitive enough to detect changes and impacts in a timely manner for correction.
- Before a concern is acknowledged, a standard of evidence that constitutes a catastrophic mortality event is demanded. Adverse influences in ecological systems are typically subclinical (effects occur in concert with other environmental factors) so such alarm bells indicating impacts are rarely acknowledged and acted upon.
- Failure to achieve the stated (or promised) mitigation strategies to reduce and/or compensate for environmental impacts have been repeatedly demonstrated by prosecution under Federal legislation.
- Coal mines entirely remove existing, functional ecosystems replacing them with a completely foreign and poorly understood state. This altered state can have effects on ecosystems, water quality, lands, and fish and wildlife populations tens and possibly a hundred kilometers away from mine sites.
- Response monitoring, using mostly wildlife presence/absence information creates the impression reclaimed mines benefit wildlife, mitigation is

appropriate and this rationalizes the initial approval for mine development as well as the development of future mines. Considering composition, seasonality and source, coal mines are a population sink for some species.

- The capability to address changed environmental state is not included in management plans and may never be possible in the case of surface mines in the Eastern Slopes of Alberta's Rockies.
- Mine-site reclamation, as practiced, replaces intact, functioning and natural ecosystems with ill-adapted ones dominated by non-native plant communities that may need constant tending to persist.
- Government standards, oversight, monitoring and regulatory enforcement are insufficient to validate the promises made prior to mine development by governments and mine proponents for effective, "stringent" environmental protection during and after mine development.
- Legacy issues from coal exploration and development are rarely profiled and any learnings are routinely ignored. Coal mines in the Eastern Slopes are shown to produce significant issues with selenium contamination of receiving waters. The impacts of selenium on the aquatic environment and fish are not trivial. Current treatment methods are at best, concepts, not proven technologies and have not been demonstrated to be workable at mine scales, over lengthy time periods, including beyond the mine life.
- Every independent cumulative effects assessment and associated study indicates that maintaining the status quo in land use (i.e., increasing the footprint) leads to, or has exceeded the thresholds for ecological integrity and resilience. Maintenance of any metric of ecological integrity (i.e., water quality, stream flows, biodiversity) cannot be assured with coal development, on top of timber harvest, petroleum development, and recreation (especially motorized forms).
- The Eastern Slopes of Alberta's Rockies are not a frontier of unrealized possibilities—instead, they are a busy landscape where expectations already exceed the ability of the landscape to absorb these dreams. There are no longer places in the Eastern Slopes (including current Category 4 lands) where coal development can be safely, effectively and environmentally accommodated.

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Background:

In the deliberations on a future coal policy for Alberta it would be useful for the Committee to look backward and consider the history of the environmental effects of past coal exploration and development as a guide for recommendations about coal (and land use) in today's and tomorrow's Eastern Slopes. We are a group of retired Provincial Fish and Wildlife biologists with extensive experience with coal exploration and development that spans nearly 50 years:

Lorne Fitch, P. Biol. (1971-2006)—Fisheries biologist (Central and Southern Alberta), Regional Habitat biologist (Southern Alberta), Regional Fisheries Management biologist (Southern Alberta), Provincial Riparian Specialist, Adjunct professor University of Calgary (2004-2018).

Jeff Kneteman (1982-2020)—Habitat and Wildlife biologist (Northeastern Alberta), Senior Wildlife biologist (West Central Alberta).

Richard Quinlan (1982-2012)—Fish and Wildlife Habitat biologist (West Central Alberta), Wildlife biologist (Southern Alberta), Species at Risk biologist (Southern Alberta), Provincial Species at Risk biologist, Section Head of Non-Game, Species at Risk and Wildlife Disease, Environmental instructor Lethbridge College (2011-2018).

Kirby Smith (1976-2010)—Wildlife biologist, Wildlife Habitat biologist, Senior Wildlife biologist (West Central Alberta).

George Sterling (1974-2014)—Fisheries Research biologist, Fish and Wildlife Habitat biologist, Senior Fisheries biologist (West Central Alberta).

With experience that includes every watershed from the Crowsnest Pass to Grande Cache, we have:

- provided input for terms of reference for Environmental Impact Assessments (EIA) related to coal mine development;
- reviewed and monitored coal exploration programs;
- reviewed and provided subject matter expertise for coal development EIAs;
- reviewed and monitored coal mine development phases;
- provided input to the departmental Development and Reclamation committee;
- inspected, measured and researched impacts of coal mine development on biodiversity elements;

- undertaken investigations into mine infrastructure and operational failures resulting in chronic and acute habitat and biodiversity losses;
- instigated and participated in environmental prosecutions related to coal mine issues; and,
- reviewed, monitored and researched reclamation, restoration, compensation and mitigation related to coal exploration and development (as well as other land uses).

Guidance from Cumulative Effects Assessments—Is there room for new coal mines?

Cumulative Effects Assessment (CEA) is a powerful tool, if applied at the regional scale, to measure the extent of all past land use and development footprints. The ability to then project forward is key to understanding both benefits and consequences of impending and proposed land use developments.

As the development footprint accumulates, CEA provides a practical, pragmatic way to assess future plans, and weigh those plans against key economic, environmental and social thresholds. We cannot plan well for something we cannot see, especially the future. CEA provides factual knowledge allowing an informed choice to be made about future options. As a pathway to a sustainable future, CEA allows today's decisions to be measured against tomorrow's realities.

A number of CEA and associated studies have been undertaken in the Eastern Slopes of Alberta's Rockies: Sawyer and Mayhood 1998; Flathead Transboundary Network 1999; Apps et al 2007; Southern Alberta Land Trust 2007; Silvatech Consulting 2008; Holroyd 2008; ALCES 2009; Oldman Watershed Council 2010; Antoniuk and Yarmoloy 2011; Stelfox and Yarmoloy 2012; Weaver 2013; Fitch 2015; Southern Foothills Study 2015; Weaver 2017; Alberta Biodiversity Monitoring Institute 2017; Farr et al 2017; Farr et al 2018a; Farr et al 2018b; ALCES 2020; Apex Geoscience et al 2021.

Every independent cumulative effects assessment and associated study indicates that maintaining the status quo in land use (i.e., increasing the footprint) leads to, or has exceeded the thresholds for ecological integrity and resilience. The cumulative effect of human activities is now beyond the range of natural variation under which most species evolved. As an example, the amount of erosion-generated sediment from human activity now exceeds the natural range of variability by several orders of magnitude (Southern Foothills Study 2015).

Maintenance of any metric of ecological integrity (i.e., water quality, stream flows, biodiversity) cannot be assured with coal development, on top of timber harvest, petroleum development, and recreation (especially motorized forms).

The Alberta Chapter of The Wildlife Society commissioned a cumulative effects study of the Oldman and Bow watersheds to consider past, present and future land uses (ALCES 2020). The results of this exercise indicate cumulative effects present substantial risk to bull trout and Westslope cutthroat trout (both "*Threatened"* Species at Risk) and grizzly bears (also "*Threatened"*), now, in the Southern East Slopes. The cumulative effects exercise confirms that the linear footprint (i.e., roads/trails) and the spatial footprint (i.e., logging, mining, oil and gas extraction) require reduction and restoration, if threatened trout and wildlife species are to be maintained.

Government, regulators and land use proponents have an aversion to undertaking or accepting the results of regional CEA, for a variety of reasons:

- CEA is viewed as too complex, an assessment of "everything on everything";
- It is viewed as out of scope for individual projects because of narrow policy guidelines;
- There is a tendency to avoid the past land use footprint in favor of setting a baseline of current conditions to assess the implications of new development;
- Concerns are raised over data availability and costs of undertaking CEA;
- Arguments are mounted over the predictive capability and framework of models, as well as the ability to understand and assess multiple stressor interactions;
- CEA results generally provide a message that the additive amount of development can have negative social, cultural, health, economic and environmental implications;
- Results generally indicate the existence of limits, constraints, costs and consequences;
- It may point out that new development can only occur after the footprint of past development has been successfully erased, which requires patience and commitment to landscape restoration;
- There is less latitude for politically-motivated decisions on single-sector interest developments;

- A focus is created on accountability through monitoring—how much, how long, how effective— and how to use the information to guide operational decision-making, regulatory oversight and enforcement; and
- Because a CEA may suggest constraints on development, we don't want to hear and acknowledge negative, unhappy results.

To ignore the consistent message from existing regional CEA studies and not proceeding with others is irresponsible and leads to adding more land use pressures to an already busy, crowded landscape. The losers are fish, wildlife and native plants, as well as other metrics of landscape health and integrity of concern to Albertans.

Coal Exploration—Carving up the country:

The scars from exploration programs of the "coal-rush" of the 1960s and early 1970s barely had time to heal when the recent one reopened many old trails and added many more new exploration roads. This era also contributed to proposals for coal strip mines in almost every major watershed throughout the Eastern Slopes. It was the "free-for-all" of early coal development throughout the Eastern Slopes that led to the 1976 Coal Policy, because the Alberta public were appalled by the devastation. It seems like déjà vu, again.

About the same time that the Coal Policy was rescinded, the Alberta Energy Regulator (AER) rescinded a document titled "Directive 061: How to Apply for Government Approval of Coal Projects in Alberta". Directive 061 dated back to 1978, not long after the Coal Policy was instituted. Including appendices, it was over 300 pages long and laid out extensive and detailed information requirements for applications to develop coal mines as well as guidance for coal exploration.

Directive 061 has been replaced by AER "Manual 020 Coal Development", which is 42 pages long and contains virtually no information requirements. It has scant guidance on coal exploration programs.

One might think that something as extensive as a coal exploration program, with a considerable and lingering footprint would require a company to provide a detailed impact assessment before the AER issued a permit. With bighorn sheep, mountain goats, grizzly bears, Athabasca rainbow trout, bull trout and cutthroat trout within the footprint of activity there is an expectation of information on

recent fish and wildlife inventories, plus botanical summaries, especially of scarce, rare or imperiled species like whitebark and limber pine.

Critically, applications should recognize and include where the critical habitats are, for avoidance by industrial disturbance. It does not appear that the AER routinely notifies applicants that activity in watersheds containing species-at-risk trout requires notification to Department of Fisheries and Oceans for necessary reviews by that agency. Since management and protection of federally listed species-at-risk are a joint federal/provincial responsibility, the AER does not seem to understand its role in that context.

Applications from coal companies follow a similar pattern, a reliance on "desk-top" analyses. This is code for perfunctory searches of Government of Alberta data bases and referral maps on fish, wildlife and plants. As a starting point there is nothing wrong with this approach. The problem is, this seems to be the endpoint of acquiring information that would allow the company and the regulator to assess risk and make informed decisions about the exploration activity.

As such, this desk-top method is not robust enough to use exclusively for decision-making. It is a starting point, a set of guidelines to understand what additional information has to be collected, the timing of the collection, the appropriate methodology, how detailed and robust the assessment should be, to better understand impacts and avoid, reduce or mitigate the negative effects of a proposed land use activity (Fitch 2021).

Because of the limited data available, short turn-around times for referrals, and outright lack of intra-government referrals in many cases, subject matter experts in Alberta Environment and Parks are rarely consulted and fully informed decisions are seldom made. In addition, most land use and regulatory staff are not fully qualified to interpret fish and wildlife data or input, particularly to understand data gaps and situations that require subject matter expertise to interpret risk to population sustainability. Cumulative effects and future land use activities which contribute to an industrial footprint are not assessed. Cumulative effects always exceed the superficial and uninformed assessments of regulators.

Unfortunately, the AER system is geared to rapid assessment of applications (often with an automated review) and a speedy approval, with a checklist approach to very complex questions. This is not an effective review of potential

issues from coal exploration that could impact fish, wildlife, biodiversity, water quality, water quantity and cumulative effects.

Coal Mine Development—Where do you want holes in the Eastern Slopes?

Compartmentalizing the Eastern Slopes, especially into "multiple use" or coal categories has not worked to protect watersheds and biodiversity. Rather it has produced a balkanization of multiple abuse. A new vision is required that is ecosystem based, not based on economic interests and dividing the Eastern Slopes into units that are indefensible in light of more enlightened thinking about landscape/watershed integrity.

There is a presumption, based on legislation (i.e., *Mines and Minerals Act, Coal Conservation Act* and *Responsible Energy Development Act*) that the starting point is coal development, *per se*, and it is in the public interest, even before consideration of environmental issues. This then sets the stage for discussions about what conditions and restrictions are applicable, but not whether or not coal development should proceed.

The opportunity for Albertans to participate in hearings related to coal mine development are severely constrained by the "directly and adversely affected" rule, unless the hearing is a joint federal/provincial one. The rule is so stringently applied that most Albertans cannot qualify. Since coal mines are proposed for public land in the Eastern Slopes, with few or any residents, rarely can any group or individual participate in the decision-making process. This means the opinions and expertise of many Albertans is statutorily ignored. In fact, the writers of this submission would be unable to provide critical perspectives, context and information to decision makers under these strictures.

Impact assessments rarely provide a good measure of the range of natural variation, since they are only undertaken over short periods of time (generally less than three years). This narrow focus has a tendency to provide for ecological benchmarks inappropriate for discerning impacts and the setting of realistic targets for mitigation.

There is much reliance on modelling to predict impacts and the outcomes of mitigation strategies for coal mines. However, models are imprecise and can be improved with more and better data. A model points out a direction, a course of action, but it isn't necessarily a prescription with 100% certainty. Modelled

results are only as good as the data used for input and need to be verified to provide a sense of reality. A modelled result is just a hypothesis, not a verified conclusion. Case studies (actual monitored results of impact effects and mitigation undertaken) would provide more certainty and aid in decision making.

Modelling is a surrogate for reality, providing assumptions that can be tested. The assumptions made by coal mine proponents need to be tested through a synoptic review of other surface coal mines in Alberta and adjacent jurisdictions. In particular: what is the experience from monitoring sediment generation and the efficacy of controls and containment; what were the actual impacts on stream flow; and, what was the efficacy of mitigative solutions? There is no evidence that coal proponents ever undertake this test of modelled results or are asked to by government regulators.

It would seem prudent to undertake this review rather than engage in a "doomsday" experiment, using only modelled results where there is a risk the proof becomes irrelevant because the subject (i.e., a mountain, a fish and wildlife population, a native grassland, an old-growth forest) is already destroyed. One of the reasons this is not undertaken is it is likely the results would show coal mines in topographically-challenging terrain are incapable of meeting expectations for protecting water quality and biodiversity. Based on our collective experience, it is our expert opinion that this is the case.

There is a tendency for coal proponents to avoid answers to some impacts by deferral to some other unstated, subsequent plan, action, monitoring, design or concept. It is virtually impossible then, to realistically determine outcomes and consequences of some mine operations and their cumulative impact on fish and wildlife populations and their habitats.

For the unanswered questions, adaptive management seems to be the fall-back position, without much understanding of how the concept should be employed. It does not mean waiting for failures, then figuring out a fix, but anticipating what might go wrong and having the facility to remedy the issue quickly. This assumes there are options available that are tested, timely, effective and the proponent is able (and willing) to take on additional economic burdens to affect these additional mitigative solutions.

Impact assessments for mines are generally flawed since they are fragmentary, fail to account for the range of natural variability, are incomplete and are too narrow in focus. They fail to account for all the environmental risks of coal

development and the effects of the activity on ecosystem integrity and the ability to meet biodiversity and species at risk recovery goals. Part of the issue is government biologists and scientists who are subject-matter experts do not (and are often not allowed to) participate in hearings despite the information, knowledge and expertise they would bring to a decision-making process. As a result, panels do not receive a balanced perspective of risk and often conclude that impacts on fish and wildlife are minimal and capable of mitigation.

The Alberta Chapter of The Wildlife Society (2020), an association of wildlife professionals reviewed the Environmental Impact Assessment (EIA) for the Grassy Mountain mine development. Their critical review highlights the general issues with coal mine EIAs:

- temporal timeframes for impact assessments and review are inadequate;
- additive effects are not considered or modelled effectively;
- the impacts of multiple access roads for mine operations are not addressed;
- habitat losses for multiple species and for many life history stages are missed; and
- many assumptions are false or inaccurate which reduces the credibility of the overall effort and provides poor guidance to decisions on mine applications.

Coal mine environmental failures:

Repetitive operational and structural failures at coal mines are uncomfortably commonplace and do not provide any assurance of protection for fish and wildlife populations and their habitats. This stems from systemic failures in government planning and standards, in the coal industry and on the part of those with oversight and regulatory responsibility:

- there are significant topographical constraints to mining in the Eastern Slopes that experience suggests cannot be successfully dealt with;
- planning failures continue, especially the inability to incorporate climate change and extreme weather events into structural adaptations;
- engineering limitations are glossed over and design standards set too low for prevailing conditions;
- mine operations focus more on economics than on environmental protection;
- lack of timely monitoring enhances risks and the magnitude of problems; and
- failure of oversight and regulatory enforcement means the problems continue.

High snowfall runoff and major rainfall events have happened on a regular basis, often causing flows that were well-above the levels that regulatory agencies and companies anticipated, included in modelling and for which infrastructure was designed and built. This will be exacerbated by climate change making historic rainfall, snowfall, and streamflow data increasingly out of date for planning and engineering purposes.

An overburden landslide from Coleman Collieries Racehorse coal strip mine in the early 1970s impacted Racehorse Creek, a stream containing Westslope cutthroat trout and bull trout. The company was charged under the Federal *Fisheries Act* but the charge was dismissed due to a technicality (Duane Radford, former Regional Fisheries Biologist, pers. comm. 2021). The issue was unmitigated and it is unclear what the residual effects were on trout populations and aquatic habitats.

Also in the early 1970’s an overburden dump failure and landslide on Coleman Collieries Tent Mountain coal strip mine completely covered the downstream portion of East Crowsnest Creek, a stream containing cutthroat trout. The company was charged under the Federal *Fisheries Act* and found guilty of negatively impacting trout habitat. Mitigation included the construction of two sediment ponds, to deal with continued erosion from the spoil pile (Duane Radford, former Regional Fisheries Biologist, pers. comm. 2018).

A physical habitat and biological survey of East Crowsnest Creek was conducted in 1976, part of an overall inventory of the Crowsnest watershed (Fitch 1977). At that time the sediment ponds had completely filled with eroded material from the mine workings and were a flow-through system, without any capacity to slow, accumulate or mitigate sediment from the spoil pile. It is unclear how long after the spoil pile failure occurred that the sediment ponds were constructed, but they could not have been in operation for more than two to three years. Ostensibly, the design of the ponds was based on contemporary, or best engineering principles. Fish and Wildlife staff were assured that all sediment would be contained behind the structures.

During the 1995 flood the dam forming one settling pond failed completely and the entire contents of the pond were evacuated into East Crowsnest Creek and down Crowsnest Creek to Crowsnest Lake (D. Wig, retired Fisheries Biologist, pers. comm. 2021). It is believed the cutthroat trout population of the upper portions of both streams failed shortly afterward.

Coal strip mines in the Coal Branch to Grande Cache have had similar sediment pond failures, the latest being the Obed Coal mine pond failure of 2013 that discharged massive amounts of sediment into Apetowun Creek, a tributary of Plante Creek, itself a tributary of the Athabasca River, and affected a long reach of the Athabasca River as well (Carl Hunt, retired Fisheries Biologist, pers. comm. 2018, and Agreed Statement of Facts-Provincial Court of Alberta-Between Her Majesty the Queen and Prairie Mines and Royalty ULC).

The owner of the mine, Prairie Mines and Royalty was ordered, in a subsequent provincial judgement, to fund a "dam safety research project" related to coal mine water storage. The dam safety research being conducted by the University of Alberta as a result of the creative sentencing is ongoing and will conclude September, 2021 (G. Neilson, Alberta Energy Regulator, pers. comm. 2020). The authors of the research proposal (Wilson and Beier 2017) point out:

- -there has been minimal consideration of the long-term behavior of dams for coal and oil sands mines;
- -few tailings dams have been fully reclaimed and little is understood about the aging process, or failure modes they are subject to over time; and,
- -little is known about their performance long-term with respect to erosion and/or extreme storm events.

A settling pond failure leading to Sphinx Creek (Gregg River Resources) in the early 1990s resulted in a massive release of sediment and flocculant into the stream. There was a significant mortality of Athabasca rainbow trout (designated now as "*Endangered*"). The company was never charged because the failure was deemed to be "an act of nature", a precipitation event that was not anticipated, even though other such runoff events were common in the area.

In a period from 1982 to 1993 five coal strip mines were monitored in west-central Alberta on a regular basis: Coal Valley at Robb on the Lovett River; Cardinal River Coal at Cadomin on the Macleod River; Gregg River Resources at Cadomin on the Macleod River; Smoky River Coal at Grande Cache on the Smoky and Muskeg rivers; and, Obed Mountain Coal in the Athabasca River watershed. In that time period there were a minimum of 22 serious incidences of sediment release, 12 of which were forwarded for charges under the Federal *Fisheries Act* (but no cases went forward for prosecution). These problems resulted from settling ponds insufficient to contain sediment-laden runoff resulting from heavy rainfall events as well as chronic levels of erosion from coal haul roads.

In one case at Cardinal River Coal, heavy rainfall around September 1, 1983 caused a settling pond to fail, the collapse of a mine pit and a haul road failure resulting in the inundation of Mary Gregg Creek with sediment, a stream containing Athabasca rainbow trout. Sediment from those sources filled the channel of the stream to the bank full level and into the riparian zone (1.0 - 1.5 meters deep) for approximately 400 meters downstream. The impact on the Athabasca rainbow trout population was a long-term population decline affecting not just the section of stream inundated with sediment, but downstream as well (Carl Hunt, retired Fisheries Biologist, pers. comm. 2020).

In the case of Smoky River Coal, the topography of the mine site, on very steep slopes, resulted in chronic erosion problems with every rainfall event. These coal mines in mountainous terrain were noted to have had slope stability issues, insufficient space to build settling ponds capable of containing runoff and inadequate planning for heavy and extreme runoff events, all leading to chronic erosion and sediment delivery to receiving streams. Frequent slumps, overburden failures and mudslides were common and likely many were unreported, all affecting streams containing trout, or leading to trout streams.

In response to the catastrophic occurrences in these mines there were multiple investigations under Alberta's *Water Act* and Canada's *Fisheries Act*. Some of these proceeded to higher levels of Alberta bureaucracy for enforcement decisions, but they were inevitably ended by a lack of political will to prosecute industry. A few "cleanup orders" were imposed in response to catastrophic occurrences, but charges were almost non-existent in the government culture.

In one case, where the complete water handling system of a mine was shown to be inadequate, an upgrade was ordered, during which a financial penalty, of sorts, was imposed on the company. That "penalty" was that the company would have to continue paying royalties for coal extracted until the new settling pond system was in-place, while other coal mines were exempt from paying royalties under a special program of the time.

Non compliance with water quality guidelines occurred on a routine and regular basis with all coal mines in west-central Alberta from 1995 to 2009. This coincided with a period of self-regulatory monitoring. Non-compliance for total suspended solids (TSS) frequently occurred at monitoring stations at every coal mine. Monitoring stations were primarily located at the discharge point of settling ponds, designed to reduce TSS from a multitude of coal mining activities, including mine site disturbance and activity, haul road development and activity,

pit dewatering, and valley fills. Settling ponds were the proposed solution to deal with issues of water quality, yet high incidences of noncompliance were well documented and are on file (Rudy Hawryluk, retired Fisheries Biologist, pers. comm. 2021).

Release of coal fines and/or toxic substances (including flocculants), some leading to fish kills led to many investigations. This included the release of large volumes of coal from conveyer belt systems. An estimated 12 to 15 tonnes of coal entered the Gregg River in January, 2000 following a water pipe rupture inside the conveyer belt enclosure. A similar event occurred at the Smoky River Coal Mine, where large volumes of coal entered Sheep Creek as a result of cleaning operations within the conveyer belt enclosure. Despite investigations, no charges were laid under the Federal *Fisheries Act* (Rudy Hawryluk, retired Fisheries Biologist, pers. comm. 2021).

In 2015 an un-reclaimed spoil pile on the legacy Grassy Mountain strip mine failed during a rainstorm event causing a catastrophic spill of overburden into Gold Creek, one of the last streams in the Crowsnest watershed with genetically-pure Westslope cutthroat trout. Rennie (2020) estimated the cutthroat population had declined 95% following this sediment event. The AER investigated but took no action on this incident.

A recent search of the Alberta Energy Regulator data base indicates that since 2013 there has been 9 investigations and 10 enforcement actions related to coal. These numbers seem very low, given previous history. Of the enforcement actions only 2 led to prosecution which could be interpreted as either a high level of compliance or perhaps a systematic fault in holding violators accountable.

A cumulative effects analysis of the Elk Valley, BC concluded “mining disturbance likely contributes the most intense hazard” to aquatic ecosystems (Elk Valley Cumulative Effects Management Framework 2018). Cope (2016) noted three major habitat concerns for native trout populations in the Upper Fording River, BC, as a consequence of coal mining activity: water quality, loss of tributary habitats and stream channel degradation. These are consistent with issues of existing and proposed Alberta coal mines.

Teck Resources (2019) provided information on the impact of their coal mining operations on native Westslope cutthroat populations in the Upper Fording River BC, in proximity to several coal mines. Adult Westslope cutthroat populations had declined 93% (76.3 fish/km to 8.6 fish/km) and fry and juvenile trout populations

had declined 74% (13.38 fish/100m^2 to 3.9 fish/100m^2), compared with 2017 population estimates. This impact on native trout occurred in spite of erosion protection, sediment containment and water quality treatment for selenium.

Teck Resources was charged and convicted under the *Fisheries Act* in 2021 for a 2012 discharge of selenium and calcite into the Fording River, BC, from their Fording River and Greenhills coal operations. The company was fined $60 million dollars for this offence, but the persistent discharge of deleterious substances from these mining operations was noted from 2009 to 2019.

The Independent Expert Engineering Investigation and Review Panel (2015), in an analysis of the Mount Polley mine tailings pond failure, undertook a review of failures in BC tailings dams. They found a historic failure frequency of 1.7X 10^{-3}/ dam year. The risk of a tailings pond dam failure was estimated at two failures in ten years and six failures in 30 years. Their blunt summary of the risk of tailings pond dam failures was: “It is axiomatic that nothing in engineering or in life, can be assured with 100% certainty.”

A meta-analysis of the effects of coal mining on aquatic biodiversity in the US found watersheds impacted by mining had 32% lower taxonomic richness and 53% lower total abundance than unmined watersheds (Giam et al 2018). These effects occurred across all taxa investigated (i.e., invertebrates, fish and amphibians). The authors also concluded that: “Even after post-mining reclamation, biodiversity impacts persisted”.

Coal mines continue to be proposed for steep, erodible terrain in the Eastern Slopes. These high elevation areas are difficult, if not impossible (in any sense of relative time) to vegetate and reclaim. The procedure continues to be that heavy machinery (coupled with explosives) totally removes soil and rock overburden and then the coal beneath. This transforms steep landscapes from being unique, sensitive and relatively stable ecosystems to ones blasted, shattered, excavated, cut and dumped into unstable piles of rock, gravel, dirt and dust. The areas are highly vulnerable, at the mercy of rain, snow, and wind, both during the mining phase and well beyond.

The expectation is that climate change will produce greater weather variability, with higher rainfall events, more frequent and unpredictable deluges. This will exacerbate current situations of erosion and sediment transport, mine structure failure rates and increasing inability to provide any reasonable reclamation of mined areas.

Experience strongly suggests a culture has developed in government that once a coal mine is approved a “hands-off” attitude is taken to deal with monitoring, environmental problems, regulatory oversight and enforcement. If this policy of complacency and lack of accountability continues with new mine developments it will be at the expense of water quality, biodiversity maintenance and watershed integrity.

What do coal mines do to fish?

Adverse impacts on fish populations can be categorized as follows:

1. Loss of critical physical habitats from sediment, concretions, stream channel alterations (and infilling), loss of tributary streams, and riparian buffer losses.
2. Water quality shifts from sediment loading above normal background levels and impacts from contaminants (e.g., selenium, calcite, pH).
3. Hydrologic shifts from land clearing, roading and drainage networks that increase the magnitude and frequency of flooding, impacts on physical habitats (i.e., additional erosion, sedimentation, channel instability) and alter natural stream/ground water flows that impact spawning and overwinter survival.
4. Chronic and acute sediment additions that cause cementing of substrate, infilling that affects trout spawning, incubation and aquatic insect production and loss of deep-water survival habitats.
5. Physiological impacts to trout including noise, disturbance and sediment plumes that increase stress and mortality.

Coal mining impacts entire watersheds, inclusive of major streams and rivers. Small, often seasonal tributaries are used as dumps for overburden, drainage networks are disrupted and riparian areas which are important buffers for water quality are truncated and lost. These actions fragment and minimize the essential watershed pieces that form critical habitat for trout.

A focus on mitigation for only the permanent, larger streams where trout exist misses the concept that an entire, intact watershed is what fish depend on, for stream flow, habitat elements like large woody debris, temperature moderation and a supply of substrate suitable for spawning and benthic insect production.

Removal of tributary systems robs trout of those essential pieces of sustaining habitat.

Caskenette et al (2020) provide guidance on critical habitat that is relevant for all species-at-risk trout. The authors, based on extensive reviews, provide an inclusive definition of critical habitat. The authors point out, "Performance of the riparian zone is often dependent on the state and use of the upland areas. Although the science advice in this document pertains to *Critical Habitat* associated with the riparian zone, it is important to note that identifying riparian *Critical Habitat* will not mitigate threats to upland areas. Some upland areas may also be disproportionately important in maintaining attributes of aquatic *Critical Habitat* features, and therefore warrant protection." This is essential advice that adhering to the provisions of the *Species at Risk Act* for coal mine development will require attention to more of the watershed than the areas trout occupy.

Surface mining results in higher streamflow and storm-generated runoff (Sullivan 1976; Collier et al, 1970; Touysinhthiphonexay and Gardner 1984), primarily because of compaction of mine spoils. Bare soils (overburden) have lower hydraulic resistance than soils with dense sod cover and produce double the overland flow and 10 times more sediment than spoils covered by topsoil alone (U.S. Forest Service, 1980c).

Waters (1995) concluded "Strip mining for coal generates the most erodible spoils" and is the largest single contributor of surface-mined spoils. Glancy (1973) found annual sediment yields of 218-2,670 tonnes/km^2 from mined areas; undisturbed areas yielded only 21-326 tonnes/km^2. Musser (1963) found that sediment yields from forested areas increased 1000 times as a result of strip mining.

Part of this sediment export is from roads. Unpaved roads are a major sediment source, increasing landslide erosion rates 10-300 times and sediment production rates an order of magnitude or more (Donahue 2013). Unpaved logging roads, equivalent to mine roads, under heavy use (more than four trucks/day) generated 500 tonnes of sediment/road km/year, had a sediment production figure of 500,000 kg/ha and delivered 70,000 kg/ha of sediment/road (Cederholm et al 1980).

In the analysis of extreme flow events and maximum probable floods the probability of multiple extreme rainstorm events, close together and possibly coupled with rain-on-snow events does not seem to have been taken seriously in

mine designs. As a result, this influences the capacity and efficacy of sediment ponds and the impact of these flow events, coupled with substantial erosion from mine workings, on water quality in receiving streams.

Modelling results of the risk of failure of one, or multiple sediment controls and containment features, is deemed by coal mine proponents to be remote, yet failures continue to happen, with frequencies greater than predicted.

Multiple studies confirm the negative effects on trout of increased sediment loadings, the impacts on spawning and rearing and on aquatic insect production, the primary food sources for trout (Klamt 1976; Cederholm et al 1980; Lemly 1982, 2019; Chapman and McLeod 1987; Weaver and Fraley 1991; Suttle et al 2004; Much 2010; Kuchapski 2013).

Coal mines have high water demands and it is unclear how these demands can be accommodated and still ensure adequate instream flow needs for fish (and the aquatic environment) can be met. Since coal mine water demands are year-round and stream flows are minimal overwinter, there is no way to ensure the instream flow requirements overwinter can be met to allow trout survival. Since this would diminish habitat for many trout that are listed as *Endangered* or *Threatened*, coal mines would be in violation of the Federal *Fisheries Act,* Canada's *Species at Risk Act,* and Alberta's *Wildlife Act.* The effects of hydrologic shifts and ground water alterations on trout populations are detailed in Brown and MacKay 1995, Power et al 1999.

There are upstream and downstream trends in the amount of physical habitat in rivers. Rosenfeld et al (2007) have demonstrated that based on hydraulic geometry, optimal flows for habitat proportionally increase as streams become smaller and decrease downstream as stream size increases. From their work they conclude these nonlinear downstream trends in habitat suggest that fixed flow percentage approaches may underestimate optimal flows for certain types and certain places along streams and rivers, for example, headwaters. This is an issue about effective instream flow need determination for headwater systems where coal mines are, or could be located.

Stream flow data is often only available for a single location far downstream on a larger stream or river, so assessing trends in headwaters stream flow, much like with the physical habitat, relies on extrapolation to conditions and characteristics of these smaller streams. Others have observed this trend and have suggested

these streams should be classified according to size and that this classification should be related to critical ecological values (Jowett and Hayes 2004).

Genetic abnormalities and high mortality in trout populations from selenium contamination are significant problems for coal mines in the Eastern Slopes. The critical impacts of elements like selenium from overburden are dealt with in Kuchapski (2013), Kuchapski and Rasmussen (2015) and Lemly (2019). Holm et al (2003) found increased incidences of edema and spinal deformities in rainbow trout fry and increased frequency of craniofacial deformities in brook trout fry from a selenium contaminated site in a coal mining area of the McLeod River drainage. Holm et al (2005) found a significant relationship for rainbow trout larvae (but not brook trout larvae) between the amount of selenium in eggs and the incidence of developmental abnormalities, all which would impair survival. The comparisons were made between eggs collected below a coalmining site (i.e., Luscar Creek, McLeod River drainage) and from reference streams not associated with coalmining.

Adverse effects on native trout at the population level—reproductive failures in exposed streams, lower trout population densities and a shift in populations to less sensitive non-native trout—have been documented in Coal Branch streams affected by coal mines (Klaverkemp et al 2005). A 92% decrease in rainbow trout populations was observed in mine-affected streams and the decrease could only be explained by selenium exposure (Kuchapski and Rasmussen 2015).

Selenium concentrations in trout tissue were at higher levels in streams exposed to mining and adverse effects were predicted for trout populations in these streams than in unimpacted reference streams (Casey 2005). Palace et al. (2004) found that most bull trout (>90%) captured immediately downstream from coal mining activity in the McLeod River headwaters have concentrations of selenium that would be expected to impair recruitment. Mackay (2006) studied fish tissue selenium data from near three coalmines in the upper McLeod and upper Smoky River drainages in west-central Alberta. He reported that selenium concentrations in rainbow and brook trout were usually greater than the thresholds for toxicity effects in mining-exposed streams compared to reference streams, particularly in the tissues of fish collected from waters draining the Luscar and Gregg River mines.

Results for native rainbow trout and data from other Alberta studies (comparing selenium concentrations in fish tissues to toxicity effects thresholds) near coal mines in west-central Alberta indicate that adverse effects on various fish species

are expected in exposed (i.e., coalmine influenced) streams compared to reference streams.

There is an abundance of evidence that selenium from Alberta coal mines damages aquatic life. While monitoring is important and imperative, what is crucially needed is action to reduce contamination and prevent further pollution.

No operating coal mines have successful treatment methods and such mechanisms are at best concepts at this point, not proven technologies for reducing selenium concentrations to levels safe for aquatic organisms. Legacy coal mines and likely old coal processing facilities may continue to contribute selenium to surface waters. Without long-term, proven results from selenium reduction technologies to levels below toxicity thresholds, the best option to ensure selenium pollution does not impact fish populations and downstream water quality is not to approve new coal min

The overriding conclusion from a large body of evidence and experience is that the aquatic environment is harmed by coal mining, and trout and coal mines cannot coexist.

What do coal mines do to wildlife?

Adverse impacts on wildlife from coal mining can be categorized as follows (modified from Wyoming Game and Fish Department 2010):

1. Direct loss of habitat.
2. Physiological stress and behavioral shifts, including effects of chemical contamination.
3. Disturbance and displacement of wildlife.
4. Habitat fragmentation and isolation.
5. Alteration of ecological functions and process.
6. Introduction of competitive, predatory or parasitic organisms.
7. Secondary and cumulative effects from increased access and additional development.

There are several misconceptions about the impacts of development on wildlife and the responses of wildlife to human disturbance that need to be addressed:

The first myth is that wildlife just moves out of the way and there is no impact because wildlife relocates to unaffected, adjacent habitats. This contradicts a

fundamental axiom of population ecology. Populations of organisms increase to fill vacant, suitable habitat and then are regulated by the essential component of their habitat that is in the least supply. Examples of essential components would include winter range for ungulates, breeding, nesting and brood rearing areas for forest birds.

Existing populations of wildlife occupy the habitats that are suitable; areas that are unsuitable are not used, or are used infrequently. When development displaces animals from suitable habitats, they are forced to use marginal habitats (that do not meet any or all of their life cycle requirements and become population sinks) or, they relocate to unaffected habitats where population density and competition for resources with an existing population increases.

Not all habitats are created equal, are equally used year-round or between years, are equally distributed, or are equally critical. However, all habitats have to be present to ensure species survival over the range of variability. All habitats have to be connected to ensure species survival over the long term. Multiple options for key habitats are important and shouldn't be viewed as surplus to a species needs.

Consequences of displacement, competition and reduced habitat are lower survival, lower reproductive success, lower recruitment and lower carrying capacity. All lead to population-level impacts.

The second myth is animals seen near developments indicate they have become accustomed to and are not affected by activity. Individuals within populations show variable responses and tolerances to disturbance. Some animals may acclimate or modify behavior in response to repetitious, non-threatening or low-grade activity. Some species have adapted to human activity (none are in the species-at-risk category). Some species are habitat generalists and are not as affected by disturbance as other species.

However, other segments of the population may remain very sensitive to disturbance. This is particularly true of habitat specialists, which includes all of the species-at-risk. The health of the overall animal population depends on the ability of all segments of the population to effectively use and have access to limited resources.

Displacement is not necessarily evident if some animals remain visible within an area subject to disturbance or human activity. Presence of animals does not

indicate that the animals are subject to no negative effects; physiological stress may not be visibly apparent.

A third myth is seasonal use stipulations, habitat protection guidelines, standard operating procedures and reclamation practices are adequate mitigation for wildlife resources affected by development. “Standard operating conditions” have not been researched or reviewed to determine efficacy at the stated objectives, especially at regional and local scales. Random reviews show significant rates of non-compliance with standard operating conditions (up to 60% in one compliance check). Oversight is clearly lacking. Guidelines for development are usually minimal requirements based on economic/political compromise, and subject to negotiation. Much of this attempt to mitigate the negative effects fails to account for cumulative effects, the additive feature of land use activities and footprints. Reclamation occurs at a much slower pace than that of coal development and there is a significant backlog that adds to the cumulative footprint. The ability to restore coal mine footprints to a comparable, pre-disturbance habitat function is inexact, problematic and impossible within relevant time scales.

Research on the efficacy of wildlife mitigation is lacking and typical procedures are repeated without an empirical base to determine adaptive management and rates of success. At larger scales many species at risk continue to decline in the face of an increasing development footprint, even with the application of a variety of administrative protection guidelines.

The last myth is the amount of physical disturbance is small in comparison to the land base and the impacts to wildlife are equivalent to the area affected. The collective area of directly disturbed land may be small in relation to the land base, but the influence of the footprint and activity extends to a larger area where proximity causes stress, avoidance, increased mortality and decreased use. Avoidance and stress response impairs remaining habitat function by reducing the capability of wildlife to use habitat effectively. These impacts are especially problematic when they occur in or adjacent to limiting habitats such as critical winter ranges and reproductive habitats.

Existing wildlife habitat is essentially eliminated with the cycle of removing and stockpiling topsoil, blasting, removing the overburden and dumping the overburden into adjacent valleys when there are no pits to backfill. In addition, there is the development of an extensive infrastructure for coal processing, loading facilities, rail lines and the road network capable of withstanding enormous truck traffic to transport the coal and overburden.

The 24-hour, year-round activity and disruption of the landscape fundamentally sterilizes the area to wildlife until mining ceases. This is particularly problematic for large carnivores in areas that have a narrow band of suitable habitat free of other influences such as the southern Eastern Slopes of Alberta's Rockies. It has also altered the movement of mountain caribou over Caw Ridge north of Grande Cache (Smith 2004) contributing to the *Imminent Threat Assessment* of the Redrock-Prairie Creek herd by the federal Minister of the Environment and Climate Change. Moreover, these impacts on wildlife are additive to those of other anthropogenic activities, like adjacent coal mines, logging, roads, petroleum development and recreation, none of which are routinely factored into cumulative effects assessment studies.

Grassy Mountain and Tent Mountain, legacy open-pit coal mines in the Crowsnest Pass represent unreclaimed and partially reclaimed situations, respectively. Both had resident populations of bighorn sheep and possibly mountain goats prior to mining. Post-mining, these areas have only sporadic and occasional use by bighorn sheep, at very low densities (Greg Hale, former Area Wildlife Biologist, pers. comm. 2021).

Selenium is an emerging issue concerning wildlife populations. Selenium levels in whole blood of ungulates captured on coal mines in Alberta are higher than all other populations sampled in western North America (Kneteman 2016). There was low variability in selenium levels among sampled animals indicating that high levels of selenium in the coal mine footprint did not allow any sampled individuals to avoid high selenium intake from mine-site vegetation.

Wayland et al (2006) measured levels of selenium in water samples, caddisfly larvae and eggs of American dippers nesting on the Gregg River downstream from coalmines, and on reference streams in the same general vicinity. Selenium levels in water samples and caddisflies collected from sites near dipper nests on the Gregg River were greater than those collected from sites near nests on reference rivers. The mean selenium level in dipper eggs from the Gregg River was significantly higher than it was in eggs from reference streams. Concentrations of selenium in eggs were significantly correlated with those in water samples. The maximum selenium level in eggs from the Gregg River may have been high enough to warrant concern from an ecotoxicological perspective.

Wayland et al (2007) presented the results of a dietary-based assessment of the risk that selenium may pose to American dippers and Harlequin ducks on a coal mine–affected stream (i.e., the Gregg River, McLeod River drainage). Simulated

dietary concentrations predicted average hatch failure rates on the Gregg River would be 12% higher in American dippers and 8% higher in Harlequin ducks than at reference streams, but corresponding values were only 3% higher for both species when predicted egg concentrations were used. They also found unexpectedly elevated levels of selenium in insects from reference streams and the authors suggested that the birds may have evolved a higher tolerance for dietary selenium in them. It is unknown whether the high selenium concentration in the insects from reference streams was from local natural sources or was transported there from contaminated sites by animal movements.

The consequences of high levels of selenium in wildlife (i.e., death, reproductive failures, reduced fitness) are difficult to detect (Flueck et al 2012). Adverse influences in ecological systems are typically subclinical (effects occur in concert with other environmental factors) so such alarm bells indicating impacts are rarely acknowledged and acted upon.

Conclusions on the effects of coal mining on wildlife are that use is sterilized during the mining phase and habitat mitigation from mine reclamation is nuanced and dependent on species.

Mitigation: Band Aid or Cure?

A variety of terms are used to describe how impacts of development can be ameliorated. Mitigation refers to reducing impacts. Compensation recognizes a resultant loss and works to recreate lost habitats, often at other locations but with accountable, measurable outcomes. Off-setting, remediation, reclamation and restoration may be the mechanisms. These terms are often used interchangeably.

One of primary goals is to compensate for fish and wildlife population and habitat losses with a goal of no net loss of existing populations and a net gain through recovery actions (or off-setting) to ensure populations continue to persist into the future, with assurances of resilience to natural and anthropogenic disturbance. The literature seems replete with instances of problems with mitigation, failures, lack of compliance, inability to replicate habitat structure and function, and monitoring gaps with mitigation plans:

Harper and Quigley (2005a, b) reviewed progress and made several observations and conclusions about mitigation effectiveness. They found uncertainty on fish-

habitat linkages with the consequence being that the goal of no net loss was largely not being met. Only 14% of proponents complied with mitigation plans, there was inadequate record keeping, a lack of standardized approaches to measure mitigation effectiveness and a general lack of monitoring, or monitoring that was of too short an interval to effectively demonstrate trends towards meeting no net loss goals. Quigley and Harper (2006a, b) in a wider view of projects substantiated that compliance was poor, monitoring data was superficial and there was inadequate time allocated to conduct scientifically rigorous, quantitative assessments.

Zedler and Callaway (1999) and Tischew et al (2008) related that long-term success rates and efficacy of aquatic mitigation projects remained largely unevaluated, or were misjudged as to effectiveness making it difficult to further develop and adapt plans and projects for future mitigation needs. Horak and Olsen (1980) pointed out that the overall lack of standards, criteria and monitoring mean the metrics for fish and wildlife mitigation effectiveness are unknown. Without such measures we may continue to do the same things over and over, but not achieve equitable mitigation. The lack of long-term timelines to measure full functionality of mitigation projects was seen to be a flaw by Scrimgeour et al (2014).

In reviewing wildlife mitigation measures, van der Grift et al (2012) noted that monitoring research focuses on use (i.e., presence/absence), but not on the question of effectiveness. One does not equate to the other as is the case in ungulate use of reclaimed open-pit coal mines as compared to whether or not the results of reclamation represent an equivalent replacement for lost, natural habitat. The authors concluded that without quantitative evaluations of the effectiveness of mitigation measures, the continued viability of wildlife populations is compromised and ineffective measures may persist through other projects.

Lievesley et al (2016, 2017) in evaluating mitigation success of wetland and riparian habitats found only one third of sites met both an ecological and a compliance metric. Designs often failed to mimic structure and function of natural habitats, constructed habitats did not have a consistent and increasing trajectory to success and measured extents of restored and constructed habitats were inconsistent from project to project. The authors also noted that lost habitats are undervalued while habitats gained through mitigation are overvalued. Monitoring is not standardized so comparisons are difficult. Most striking though, is the

conclusion by the authors of the assumption by proponents that habitat structure and function can be recreated. This does not have general support in the scientific community. The proof is lacking.

Theis et al (2020) evaluated 577 mitigation projects, finding crucial problems persisted, and even high levels of compliance did not guarantee a high degree of function. Function often scored lower than compliance, a troubling finding if only compliance is used as a metric of mitigation success. Ecosystem function following mitigation was hard to assess and evaluate in projects because no clear guidelines existed. New ecosystem creation (like mine-site preparation for wildlife mitigation) had more uncertainty than restoring existing systems. Concern was raised over proper assessment of ecological thresholds (like population carrying capacity) for each ecosystem, which can limit the overall effect of mitigation. This can lead to a situation of over-promising, but under-delivering on mitigation.

A review by Post (2020) of the proposed Grassy Mountain coal mine impact assessment found significant flaws with the mitigation suggested for *Threatened* Westslope cutthroat trout. The conclusions were that: the mine project would negatively impact long-term population viability; critical habitat had been underrepresented; there was a failure to properly account for cumulative effects; and, none of the mitigation or offsetting methods had been proven effective and would be transferable to the streams affected by proposed mine development.

Habitat features define the survival, abundance and distribution of fish and wildlife species, yet these critical features can be poorly understood, mapped imperfectly or missed from impact assessments. Travel corridors and seasonal stop-over habitats, important for ungulates like bighorn sheep, elk, mule deer and mountain goats as well as large carnivores may be missed in short-term impact assessments. Other key features often missed are mineral licks, dens, cavities, springs, seeps and burrows important for nesting, foraging, calving, lambing, nursery and overwintering habitats. Population dynamics are not tracked, yet an understanding of this is key to appreciating (and responding to) the vulnerability of a population to coal development and fully assessing risks and impacts.

Many mitigation strategies represent an over-simplification of the complex inter-relationships between the physical environment and the biological organisms that inhabit that environment. Without a solid understanding of all the biological limiting factors, or a sound basis for predicting the outcomes of proposed habitat manipulation, the mitigation program may well produce no significant, positive

impact on fish and wildlife populations, let alone equitable compensation for habitat losses.

All of the above brings into question whether mitigation and compensation strategies exist that can be effectively employed to deal with impacts on fish and wildlife and their habitats. This should form a cautionary note to any review and acceptance of proposed mitigation strategies for coal mine development. Mitigation employed to date has not generated anything close to an impressive record of success, let alone compensation for habitats lost or impacted.

Mitigation can lead to the vain hope we can continue to do everything, everywhere, anytime and all the time, with our development footprint effectively erased behind us. At worst it creates the impression there is still room for expansion of development and biodiversity is protected.

Fisheries mitigation realities in Alberta:

Fisheries mitigation solutions assume that:

- habitats created or improved represent ones that form critical, limiting factors and that these habitats are not already present;
- streams are not at population carrying capacity and habitat enhancements will increase abundance and biomass;
- stream productivity (benthic and terrestrial insect production) will not be a limiting factor beyond a certain trout population size;
- habitats created or improved will persist over long periods of time to permanently benefit trout populations; and
- trout abundance, distribution and biomass increase and not because of a shift in population usage of created habitats.

Quantitative monitoring <u>has not confirmed these assumptions</u>.

Pattenden et al (1998) summarized the results of five years (1991-1996) of research on instream habitat structures in southwestern Alberta, and provided information on the efficacy of these stream habitat improvement devices. These are the type of physical habitat improvements proposed and used for mitigating the impacts of coal mine development on trout streams. The short-term performance of 351 instream structures on 26 streams, in place between two and seven years and subject to less than a 1:6 flood flow was investigated. Under

those initial conditions, 63% of the structures were found to have maintained their physical stability or, had minor flaws. Sixty one percent of the structures provided the design and desired deep-water refuge fish habitat.

This information was re-analyzed to determine relationships between structure performance and fluvial and hydraulic characteristics using information in Fitch et al (1994). This investigation concluded that structures tended to perform better in stable channels with low rates of bedload transport.

Following a sizeable flood in June 1995 (≥100-year return period) a subset (149) of the original structures was re-evaluated (R. L. and L. and Miles 1996). Eighty one percent of the sampled structures had been severely damaged or destroyed due to processes of general and local scour, sediment deposition and/or channel shifting. Of the structures that were still intact (43), only 31% (13) provided the desired deep-water habitat of the original design. Overall, this represented a 91% failure of constructed habitat features to provide effective trout habitat.

The results indicated that many instream habitat structures built in southwestern Alberta were subsequently degraded by small flood events, and most did not survive a sizeable flood. In several cases, normal bed load movement simply filled in the deep-water habitat. Streams with higher gradients and subject to flashier flow regimes due to proximity to mountain slopes had the highest structure failure rates. These are the streams most often impacted by coal mine development.

Instream habitat structures provided short-term benefits, but even with appropriate design and location require regular maintenance and rebuilding to be effective under conditions of minor flood events. This is evidence that coal proponent's claims of such structures being "self-sustaining" and not requiring any scheduled maintenance, have no credence.

There are physical limits to the amount of instream habitat a river or stream is capable of maintaining throughout a variety of fluvial processes. While deep-water habitat (i.e. overwintering pools) is viewed as a limiting factor to stream-dwelling trout and hence an increase in this habitat type is regarded as a way to bolster trout populations, there are limitations. In an alluvial system, pools occur with a size and frequency that is dependent on the meander wave-length, which in turn is a property of the hydraulic regime (Bray, 1982). These relationships cannot be changed and attempts to manipulate this relationship, for example by

attempting to increase the number of wintering pools, have a high probability of failure.

As a fundamental step in stream habitat enhancement planning, candidate reaches for habitat enhancement need to be evaluated for channel stability and classified, by stream type, to assess the suitability of proposed fish habitat structures for various channel types. Rosgen (1996) provides a stream reach classification system as well as a way to evaluate the suitability of habitat enhancement structures. There is no evidence that coal proponents undertake this fundamental step in mitigation/compensation planning.

While some research indicates that, in some circumstances, instream habitat enhancement can increase fish production (Ward and Slaney, 1981; Ward, 1993) there is increasing evidence that structural measures alone do not necessarily improve fish production. Monitoring of trout population responses to instream habitat structures to mitigate habitat losses from the Oldman River Dam have not demonstrated significant, increased trout production (O'Neil and Pattenden, 1994).

Riley and Fausch (1995) documented an increase in fish numbers and biomass in enhanced sections of six northern Colorado streams. However, the authors suggested that the success was related more to the movement of fish into structures from adjacent areas, rather than an increase in fish production (i.e., growth or survival). Gowan and Fausch (1996) found when pool habitat was artificially added to streams, abundance and biomass of large trout increased, but, again, immigration from other stream segments was the primary reason for the increase.

Cunjak (1996) pointed out that stream habitat enhancements can have deleterious effects on salmonid populations if water conditions (i.e., stream flows and temperatures) are not considered. Simply increasing the number of chairs (wintering pools) increases the movement between chairs but does not increase the number of players (trout) or necessarily create the opportunity for enhanced trout populations.

Strip mine pits that are not reclaimed by infilling with overburden are allowed to fill with water as a reclamation option. These are often seen as an additional mitigation benefit to compensate for lost stream habitats; however, natural, unimpacted streams were found to be 10 times more productive for trout than mine pit lakes in the Coal Branch.

These mine pits tend to be deep, cold, with limited littoral area (the productive part of a lake). These pit lakes can be initially productive, because of nutrients available as the residue from blasting compounds (e.g., ammonium nitrate). These diminish over time and productivity becomes more and more restricted. No spawning areas are available, requiring regular stocking to support a fishery. These do not replace native trout populations or habitats in any reasonable way.

After studies of selenium bioaccumulation in mine pit lakes in west-central Alberta (the Coal Branch) it was concluded that, "high selenium exposure in metallurgical coal pits indicated that under the current mining and reclamation strategy, these lakes are not suitable for management as recreational 'put and take' fisheries" (Miller et al 2013). The authors also concluded mine pit lakes, "may pose a significant problem for managers because the selenium that accumulates in their [trout] tissue may exceed guidelines for human consumption and pose a hazard to wild vertebrate predators."

Recommendations have been made not to stock these mine pit lakes with trout because of selenium bioaccumulation and the risk to human health through consumption of these fish.

A conclusion of the research and our experience indicates that most fisheries mitigation including instream habitat structures, such as those often proposed for creating overwinter habitat, tend to be ephemeral and do not provide useful trout habitat over the long-term. The value for long-term mitigation purposes (over the active life of a coal mine and beyond) is questionable.

Wildlife mitigation realities in Alberta:

Once the coal is exhausted the mine footprint is greater than the amount of stockpiled topsoil available from mountain environments. Since only a fraction of the original organic matter can be replaced, equivalent landcover cannot be regenerated. The regulatory requirement has been relaxed to allow an "equivalent" end land use. By default, the mine footprint, previously a combination of forest and native grassland becomes "grassland".

A commercial source of grass species indigenous to the mountains has not been available because there has never been a regulated need (which would encourage the development of native seed sources). In combination with the need to minimize soil erosion, the end result is the use of fast-growing, non-native

agronomics which are highly fertilized with nitrogen to encourage rapid establishment and growth of “cover crops”. A blush of green growth provides the illusion of restoration. Revegetation efforts are presumed to provide some semblance of wildlife habitat.

Non-native, agronomic vegetation species used for reclamation have some value to wildlife, but do not replace the utility of native species for ungulate requirements year-round. While non-native species may produce a greater volume of forage, especially under fertilization, the nutritive value of such forage, compared with native species is lower, on an annual basis. Non-native species, known as “soft grasses”, lose nutritional content in dry periods and after frost. By contrast, native, “hard grasses” retain high protein levels essential for successful overwinter use by ungulates (Willms et al 1996). Weathering loss was found to be greater for non-native species, meaning they do not retain structure and may not persist under the influence of drifting snow and wind (Willms et al 1998).

The evidence used to demonstrate the value of reclaimed coal mines to wildlife tends to focus on presence/absence of a limited suite of species (e.g., bighorn sheep, grizzly bears) rather than a broader understanding of whether such lands effectively compensate for losses and form useful habitats for a broad range of species. By changing the habitat permanently, there are obviously wildlife winners and losers. All forest interior and old-growth dependent species are lost and those that use grasslands may increase.

Critical analyses of wildlife responses to reclaimed mine footprints, considering existing, legacy and proposed locations for mines from the southern to the northern Eastern Slopes indicate:

- there is an assumption that the wildlife species selected for monitoring and used to demonstrate the utility of reclaimed mine footprints are representative of a broader guild of species (Teck Coal Limited 2021). The assumption has not been tested and verified (Kneteman 2021);
- mine footprint reclamation did not benefit bighorn sheep productivity and any implications for enhancement of regional populations are tenuous;
- bighorn sheep presence on coal mine footprints is dependent on immigration from native ranges (i.e., sources) and winter lamb:ewe ratios are lower than on native ranges (Draft Management Plan for Bighorn Sheep in Alberta 2016);
- vegetation on native ranges has a higher nutrient content (Johnson et al 1968) than agronomic species on mine footprints and native ranges sustain winter

use by ungulate populations (Alberta Environment and Parks, unpubl. surveys); and,

- reclaimed mine footprints may be population “sinks” for some species, defined by habitats of lower quality not able to sustain wildlife populations and requiring high quality “source” habitats for wildlife to persist.

Achieving the objective of wildlife mitigation requires an understanding of and managing ecological processes as well as incorporating the fundamental constituents of an ecosystem: structure, scale, functions, and feedback loops. Ecological functions need to persist, and uncertainty needs to be accommodated. The vigour and persistence of wildlife populations and communities are dependent on ecological state and this shifts in response to mine disturbance. Given the complexity, restoration of coal mines to a desired state can be difficult to impossible to accomplish (Kneteman 2021).

The Gregg River mine south of Hinton has now been inactive for 19 years but has yet to be accepted back by the Government of Alberta as vacant Crown land since there is still no approved management plan for the area. The question of standards and evaluation for self-sustaining landcover and its utility for wildlife is a factor which must be considered to determine reclamation effectiveness and risk reduction.

The footprint of reclaimed coal mines may not contribute to well-defined, desirable ecological states or to a defined sustainable future for wildlife use. Sufficient time has not elapsed to determine if forage can be self sustaining without fertilization or if native species will ever recolonize mine sites. The establishment of native species in reclaimed areas is a goal of many reclamation plans, but research on reclamation vegetation indicates that although richness and native cover do increase with time, native species remain a small component of the vegetation communities (Longman 2010).

It may be impossible to restore some native grassland communities. Foothills rough fescue grasslands, prevalent throughout many of the coal leases of southwestern Alberta and associated with alpine areas throughout the Eastern Slopes, are deemed to be “most difficult to restore” and, “we lack the tools and knowledge to restore rough fescue grasslands after they are disturbed by land use activities…” (Lancaster et al 2018). These grasslands are essential winter forage for wild ungulates and their loss cannot be compensated for by non-native agronomic species.

Summary and Recommendations:

These are our considered, professional opinions, based on the evidence related to coal mine development in the Eastern Slopes of Alberta's Rockies:

1. Zoning under the 1976 Coal Policy is no longer relevant and applicable given our current understanding of water quality issues and concerns, climate change, biodiversity conservation (including federal and provincially mandated species at risk), cumulative effects assessments, understanding of ecological thresholds and monitoring information accumulated since the 1976 policy on the efficacy of reclamation, mitigation and compensation. A "multiple use" philosophy for most of the Eastern Slopes is no longer tenable. There are no longer places in the Eastern Slopes (including current Coal Category 4 lands) where coal development can be safely, effectively and environmentally accommodated.
2. Ecological integrity (measured by a variety of metrics) has been compromised by both extensive coal exploration programs, existing and legacy mines, and will be impacted negatively at watershed and regional levels by new coal mine developments. This will have cascading effects on biodiversity indices, including iconic wildlife species such as bighorn sheep, mountain goats and grizzly bears, and native trout that are watershed health indicators.
3. Experience indicates the environmental impacts of coal development are negative and incapable of being effectively dealt with by mitigation, compensation or reclamation. There are significant legacy issues from the existing footprint of coal development and there is no compelling evidence that future coal development will provide any different outcomes. In short, more coal development will create more environmental problems. Avoidance of serious, lingering environmental problems will only be achieved by an end to coal development in the Eastern Slopes.
4. Most mitigation, off-setting, reclamation and restoration endeavors are incapable of compensating for biodiversity losses in any meaningful, ecologically-relevant way. These promises set into motion unrealistic expectations that lead to project approvals and eventual failures to compensate for biodiversity losses.
5. The Eastern Slopes suffer from a siloed approach—each sector (i.e., forestry, mining, petroleum, grazing, recreation, facility development,

transportation, energy corridors, hydropower) intent on maximizing their individual interests within their own silos, without concern for the integrity of the whole landscape. This leaves the fundamental reasons for the Eastern Slopes, as articulated in the 1977 policy (Government of Alberta 1977) at the mercy of a variety of interests, each pulling their levers without the ability to override these for the benefit of watershed protection, biodiversity protection and overall landscape health and resilience. It would be more prudent to organize the management and protection of the Eastern Slopes by a unique geographic and administrative unit, rather than by sectors of interest and agencies competing with one another, each with their own management intent.

6. Coordination between Alberta government departments is touted but the results are illusionary. The development of regional and especially subregional plans (e.g. Livingstone-Porcupine Hills Land Footprint Management Plan) was meant to avoid the sector-by-sector approach yet existing plans seem to be ignored in the face of new coal development (especially exceeding the ecological thresholds set) and land use plans for the remainder of the Eastern Slopes are on hold.
7. What is urgently required is the completion of regional cumulative effects assessments, the setting of ecologically-relevant spatial and linear thresholds and progress on regional and subregional plans. These would provide the necessary direction for sector interests, like coal. Equally important is the rapid, effective reclamation of the current coal exploration footprint, before the footprint contributes more environmental issues, like erosion and sedimentation of receiving streams. This needs to begin this year and be completed within a year.
8. The process of judging the merits of a project is meaningless when development is seen to be a given, under prevailing legislation (i.e., *Mines and Minerals Act, Coal Conservation Act* and *Responsible Energy Development Act*) where all speak about "orderly, efficient and economic development", not about whether or not a project should proceed. It seems that the only argument is about what conditions or restrictions should be attached to the development.
9. Hearings on coal mine development tend to be dominated by industry consultants, while provincial government biologists and scientists do not (and are often not allowed to) participate despite the information, knowledge and expertise they would bring to a decision-making process. As

a result panels do not receive a balanced perspective of risk and often conclude that impacts on fish and wildlife are minimal and capable of mitigation. These conclusions, in light of subsequent monitoring are often wrong.

10. Statements of concern and participation by Albertans in Alberta Energy Regulator-led panels are ignored and blocked since most do not meet the "directly and adversely affected" criteria. This precludes meaningful input to decisions by panels on issues that Albertans feel strongly about and have information to share. This does not create a level playing field.
11. The mantra of stringent environmental regulations governing coal exploration and development hides a perfunctory assessment of environmental risks and concerns, failure to employ regional cumulative effects assessments, weak environmental impact assessments, as well as a lack of oversight, monitoring and regulatory enforcement by both provincial and federal agencies with such responsibility.
12. In the face of new coal mine development it will be impossible for the province of Alberta to meet its obligations for species-at-risk protection and recovery actions will be affected negatively. Alberta stands to suffer reputationally and economically, through consumer and investor avoidance of Alberta products and businesses if species-at-risk are not taken seriously and accommodated at watershed and regional levels. Legal actions by concerned parties will become prevalent and the Federal government may be obligated to step in to exercise its mandate.

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Appendix. Support and endorsement signatories.

The following are retired Alberta Fish and Wildlife Staff. The submission, “Insights on Coal Development from Five Retired Fish and Wildlife Biologists” has been reviewed and these individuals support and endorse the conclusions and recommendations:

Morley Barrett (1969-2001)- Regional Wildlife biologist, Head Wildlife Biology research group-Environmental Centre, North American Waterfowl Management Plan coordinator, Director of Fisheries, Assistant Deputy Minister-Natural Resources/Fish and Wildlife.

David Barry (1968-2002)- Fisheries research biologist, Area fisheries biologist, Fisheries management planner, Unit Leader-Fisheries Management Section, Provincial Fisheries Management specialist.

Ron Bjorge (1975-2016)- Wildlife biologist, Habitat biologist, Regional Habitat biologist, Regional Wildlife biologist, Head Wildlife Management-Parkland and Prairie Region, Executive Director-Wildlife Management Branch, Executive Director-Policy and Planning Division.

Eldon Bruns (1973-2005)- Head of Wildlife Management-Central and East Slopes regions.

Dave Christiansen (1977-2014)- Fisheries Habitat Protection biologist, Regional Habitat Head, Head Fisheries Management, Acting Regional Executive Director- South West Region, Head Fisheries and Wildlife Management, Resource Manager- Southern Red Deer and North Saskatchewan Region.

Ken Crutchfield (1969-2010)- Fisheries biologist, Fisheries Habitat biologist, Head Fisheries Habitat Development and Inventory, Head Fish & Wildlife Information, Extension and Licensing, Associate Science Director-Northern River Basins Study, Head Trust Fund, Habitat and Forestry-Fisheries Management Division, Head Resource Conservation and Planning, Director of Fisheries.

Rudy Hawryluk (1970-2009)- Fisheries biologist-West Central Region.

Carl Hunt (1964-1997)- Fisheries biologist-Central Region, Senior Fisheries biologist- West Central Region, Fisheries representative-Cheviot Coal Hearings.

Jon T Jorgenson (1978-2015)- Wildlife Research biologist, Wildlife biologist, Senior Wildlife biologist.

Rocky Konynenbelt (1976-2016)- Fisheries technician, Habitat technician.

Allan Locke (1981-2013)- Provincial Aquatic Habitat Protection biologist.

Ray Makowecki (1966-1997)- Fisheries biologist, Habitat Development biologist, Regional Director- North east Region, Fish and Wildlife Policy Director, Past-President and Director of the Cumulative Environmental Management Association (2003-2020).

Don Meredith (1978-2002)- Contract biologist, Head Fish and Wildlife Information Services, Senior Public Affairs Officer, Coordinator Information and Education.

Paul Paetkau (1968-1988)- Aquatic Pollution Research biologist, Fish and Wildlife Status biologist, Acting Director Habitat branch.

Rod Paterson (1959-1971)- Fisheries biologist.

Duane Radford (1970-2002)- Fisheries Research biologist, Regional Fisheries biologist–Southern Region, Regional Director-Southern Region, Head Fisheries Management Branch, Assistant Director and Director of Fisheries.

Harry Stelfox (1980-2005)- Resource appraisal project leader, Wildlife habitat inventory supervisor, Watchable Wildlife program coordinator, Provincial wildlife ecology specialist, Intergovernmental relations & biodiversity policy advisor.

Jim Stelfox (1974-2013)- Fisheries biologist.

John Taggart (1978-2010)- Wildlife technician, Problem Wildlife specialist, Habitat Protection technician.

Daryl Wig (1978-2012)- Wildlife biologist, Habitat biologist, Fisheries biologist / Senior Fisheries biologist, Acting Fish and Wildlife Manager-Southern Rockies Area.

Hugh Wollis (1977-2013)- Wildlife Ecologist, Senior Wildlife Habitat biologist, Senior Area Wildlife biologist.

Ken Zelt (1968-2000)- Survey biologist, Special Project biologist, Edmonton Regional Fisheries biologist, Fisheries Program Manager, Commercial

Fisheries Manager, Head Fisheries Management, Manager Fisheries Management Enhancement and Habitat Development Program, Head Fisheries Resource Allocation and Use.